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Global Value Chains and Spatial Spillovers of Economic Growth—Based on the Perspective of Participation and Status Index in Global Value Chain

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Abstract: This paper mainly analyzed the spillover effect of GVC participation on economic growth and deconstructed it from the spatial perspective. It used the spatial Durbin model to study the impact of GVC participation on economic growth in 42 countries through empirical analysis, using the World Bank, WIOD, UIBE and other databases. The results are as follows: the improvement of a country's GVC participation can effectively drive the development of its own economy and have a significant spillover effect on the economic development of its neighboring countries; The improvement of a country's GVC status not only has a great promotion effect on its own economic development, but also has a relatively obvious promotion effect on the economic development of neighboring countries.

Keywords: spatial spillover; global value chain participation index; global value chain status index

Citation: Men, K.; Sun, H.; Kou, M. Global Value Chains and Spatial Spillovers of Economic Growth—Based on the Perspective of Participation and Status Index in Global Value Chain. *Sustainability* **2022**, *14*, 15518. https://doi.org/10.3390/su142315518

Academic Editor: Bruce Morley

Received: 1 September 2022
Accepted: 17 November 2022
Published: 22 November 2022

1. Introduction

As one of the important features of global development, GVC activities closely connect countries or regions around the world through space production networks, promoting global economic development and becoming an important force in global governance. GVC production activities refer to the production process of a product divided into multiple production links, which are jointly completed by different countries or regions. In this process, intermediate product trade is particularly important. Based on the intermediate goods trade data under the BEC classification of the UN COMTRADE database, the global trade volume and intermediate goods trade volume were calculated, as shown in Figure 1. Global trade volume declined to a certain extent in 2019 and 2020. With the gradual effectiveness of the epidemic prevention and control policies of various countries, global trade rebounded significantly in 2021. At the same time, it can be seen that the trade volume of intermediate goods accounted for more than 50% and showed a total uptrend except for a slight decline in 2019. In contrast to the fluctuation and downturn of global economy and trade, the development of intermediate goods trade shows a contrarian growth state. This means that intermediate product trade plays an important role in international trade, which is also the inevitable logic of GVC's in-depth evolution. According to the World Bank (2020) [1], if the GVC participation rate continues to increase by 1%, the per capita income of individuals could increase by more than 1%. It can be seen that GVC contributes to economic growth to a certain extent.

Unfortunately, due to the long-term impact of COVID-19, increased geopolitical risks, rising trade protectionism and other factors, deglobalization and slow globalization have begun to emerge, which has affected GVC activities and will further impact global economic growth. This "anti-globalization" trend of thought will present obstacles to the trans-regional flow of production factors, the optimal allocation of resources and the diffusion of technology along GVC, thus hindering the further increase of global welfare. To be sure,

there will be twists and turns in the adjustment and development of the world economy in the future, but the process of economic globalization will not change. Therefore, a country should actively participate in GVC to improve its GVC status, so that it can benefit from GVC participation. Therefore, it is worth studying whether the global value chain can promote economic growth at the global level. At the same time, GVC activities will make the spatial correlation and spatial interaction between countries or regions become more and more close. Spatial correlation and spatial interaction should be taken into account in the research process. From the perspective of spatial economics, this paper aimed to analyze whether GVC participation will promote economic growth in the region, and whether there will be spatial spillover effects in this process. The article hopes to put forward targeted policy suggestions for GVC to participate in empowering global economic growth and realize coordinated development of regional or global economy.

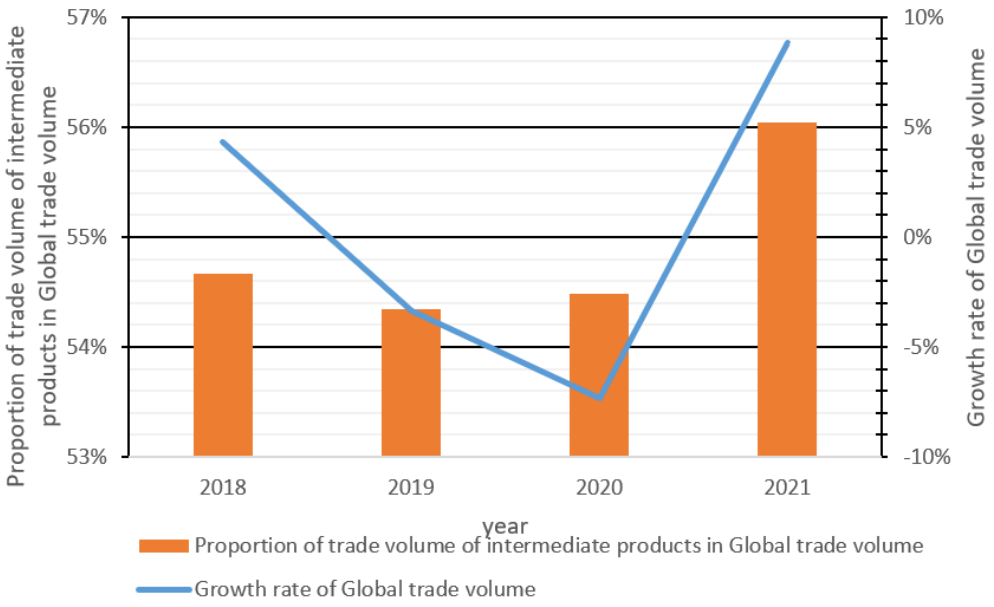

Figure 1. Growth rate of Global trade and proportion of intermediate products trade in 2018–2021.

2. Literature Reviewed

In 1985, Porter found that enterprises need to coordinate R & D, design, manufacturing, sales, and other links in the process of value creation. In view of this phenomenon, Porter proposed the value chain to describe this economic activity [2]. Thus, the internal value chain of the enterprise was formed. At the beginning of the 21st century, the transnational production and operation model has gradually risen, and the trend of global economic integration gradually became obvious. Scholars began to explore the formation theory of value chain from the perspective of global economy. The global commodity chain theory proposed by Gereffith (1994) [3]. According to the difference between "top-down" and "bottom-up" organizational forms, the theory divides the value chain into two categories: buyer-driven and producer-driven. Gereffi believed that producers and buyers jointly drive the spatial separation, reorganization and normal operation of GVC in different functional links.Henderson (1998) [4] specifically analyzed the causes and differences of GVC dual-driving mechanisms from the perspective of functional integration differences. He also paid attention to the imbalance of factor allocation, added value and division of labor interests in the value chain under this driving mode. However, throughout the 1990s, the research on GVC was always limited to the category of "commodity", and it was difficult to fully explain GVC's relationship governance capabilities, etc., until 2001, when Gereffith used the value chain theory to explain the causes of economic globalization and define the global value chain for the first time in the article "The Value of Value Chains" [5]. Since then, scholars have discussed in detail the causes, characteristics, and action paths of GVC from

multiple perspectives, including the evolution trend of value chain, industrial structure upgrading (Humphrey and Schmitz, 2000) [6], and value chain governance (Humphrey and Schmitz, 2002; Kaplinsky and Morris, 2003; Gereffi et al., 2003) [7–9].

At present, there are abundant research studies on GVC production activities and economic growth in academia. Many scholars believe that GVC production activities have a promoting effect on economic growth. Sturgeon T J (1997) [10] found through research that global production intensifies competition among enterprises of various countries and strengthens industrial connections, as this makes enterprises combine imitation with local innovation and improve their innovation ability. Fujita, M., Krugman, P.R. & Venables, A. (1999) [11] found through research that international trade can promote the spatial agglomeration of some industries and increase national welfare. Canils M C J and Verspagen B (2001) [12] found through research that knowledge and technology spillovers contribute to the coordinated development of economy. Yu J, Department E. (2014) [13] believed that the accumulation and upgrading of capital, human factors and FDI in China improved the technical complexity of China's export and promoted sustainable economic growth. Bank T W (2015) [14] found through relevant research that enterprises participate in global value chains through the export of intermediate products to promote economic development. Baldwin J R and Yan B (2014) [15] found through research that enterprises' participation in global value chain can improve their technological level and promote their global competitiveness. E Lee and KM Yi (2018) [16] believe that each country's participation in GVCS focuses on its comparative advantage sectors and production stages, which can reduce trade costs and promote economic growth of each country. Mao Z. (2021) [17] believed that a country's improvement of its domestic value chain would help to improve its participation in the global value chain, thereby promoting economic development. Zhou Y and Anwar S. (2022) [18] believed that countries with high institutional quality can promote their global value chain status and sustainable economic development through migration diversity. However, some scholars believe that global production may have both positive and negative impacts on sustainable economic growth, and even pose challenges. For example, contrary to the traditional view, globalization will make more people fall into poverty, and inequality will increase. This is mainly because Asian countries represented by China have attracted foreign capital investment with its large number of skilled labor and low wages, which has lowered the global wage level and deepened poverty and inequality (Kaplinsky, R, 2005) [19]. If a country's export products contain more unskilled labor and cannot obtain more added value through industrial upgrading, it is difficult for the country to effectively participate in global market competition. The terms of trade of the country may become worse, thus falling into the predicament of poverty growth (Kaplinsky, R, 1993, 2002) [20,21]. Kaplinsky, R., Terheggen, A. and Tijaja, J.P. (2011) [22] studied the cassava industry in Thailand and the timber sector in Gabon and found that changes in demand for these two products in high-income economies and China led to more products being exported to China. As China's demand is biased towards cheaper commodities, the unit added value of Thailand's cassava industry and Gabon's timber sector's exports to China has declined, falling into a low-end lock. However, due to the increase in demand, the overall total export income has increased, and the production cost has also decreased due to economies of scale. At present, the world economy has witnessed the phenomenon of deglobalization, such as decoupling and value chain reconstruction. Some scholars have also paid attention to this change and conducted research on it. For example, Bollen J, Romagosa H R. (2018) [23] joined three scenarios, such as China and the European Union's countermeasures, in the context of tariff increases in the United States. Through research, it was found that the increase of tariffs in the United States will lead to the decline of bilateral import and export volume between China and the United States. Ran, Cho Jung; Byeongho, LIM. (2021) [24] found that the United States' attempt to decouple from China had a great impact on GVC's supply chain. Through quantitative evaluation, it was found that decoupling has had different impacts on the United States, China and South Korea. It has had a negative impact on South Korea and China, but less of an impact on the United

States. The COVID-19 outbreak in 2019 also affected the process of global production. Through simulation, it was found that the stagnation of global production will have a negative impact on global GDP growth, especially in the service industry. At the same time, even if it is controlled, it is difficult to eliminate the negative impact in a short time (McKibbin, W, 2021; Fernandes, N, 2020) [25,26].

Tobler (1979) [27] clearly pointed out that: "All things are related, and things closer are always more relevant than things farther away". This has been confirmed because the completion of socio-economic activities depends on spatial units. In the research process of economic geography, spatial correlation analysis is very important, and can improve the accuracy of statistical and quantitative analysis conclusions (Anselin and Griffith, 1988) [28]. Anselin (1988) first defined the spatial relationship between geographical and economic phenomena as spatial effect. Based on the theoretical and empirical perspectives, it gave the identification and estimation methods of spatial effect [29]. Spatial effects include spatial dependence and spatial heterogeneity, and spatial dependence can be further divided into spatial autocorrelation and spatial spillover. According to the theory of spatial economics, spatial spillovers originate from the interrelation between the same economic activities of different spatial units (Anselin, 2010; Liu C, etc., 2022) [30,31]. The economic behaviors formed by these spatial interactions have real influence through interaction and interaction. With the rise of spatial econometrics, the theory of spatial spillover effect is becoming richer and richer, and the quantitative method has been gradually improved (Anselin, 2010; Xin, L., Sun, H., Xia, X., 2022) [32,33]. Under this background, some scholars combined GVC participation with spatial spillover effect, and used spatial econometric analysis to analyze how does GVC participation affect economic growth from the perspective of spatial spillover. Danni S U et al. (2017) [34] found that that if GVC participation in a country increased, economic development was effectively boosted both local and surrounding region. From an empirical perspective, she found that GVC participation would indeed produce a spatial spillover effect and thus promote economic development. Pan W, Genqiang L I. (2018) [35] found that the supply and demand of intermediate products in a certain region of a country showed regional distribution characteristics, which was reflected in domestic and foreign countries and among regions. This reflects the characteristics of value linkages and economic dependence formed by a country, and different regions in the country, in the process of GVC embedding, thus affirming the spillover effect of GVC embedding on economic development. Some scholars also divided the spatial spillover effect into horizontal spatial spillover channels and vertical spatial spillover channels. The embedding of regional GVC will produce indirect spillover effects through horizontal and vertical spillovers, which will drive the embedding of adjacent GVC (Ivarsson and Alvastam, 2010) [36]. Bo D and Chiara F. (2013) [37] believe that the horizontal and vertical spillover effects of FDI on power generation and distribution sectors are different. Chen Y M and Li C Y (2019) [38] found through research that China acquired horizontal and vertical spatial spillovers of pure knowledge by importing and undertaking industrial transfer from developed countries. This vertical space spillover industry transfer backward correlation effect forced the development of the manufacturing industry of China. As for the research on horizontal spatial spillover channels, the horizontal spatial spillover channels of a country or region participating in GVC mainly include export, import and pure knowledge spillover. GVC participation can promote economic growth through these three channels (Wang Jun, 2013) [39].

Some researchers point out that technology (knowledge) spillovers, FDI spillovers to technology, and resource reallocation structure are the main reasons and channels for GVC participation to produce spatial spillovers to economic growth. Some scholars believe that GVC activities can promote industrial transformation and upgrading through technology or knowledge spillovers, and then drive economic growth. Yu P and Peng G (2019) [40] believed, through empirical analysis, that technology spillovers can enhance the GVC position of the home country and other countries. In Hong L, Nie M, Management S.O. (2013) [41] it was found that one of the main drivers of global value chain upgrading is to

obtain the technologies required for enterprise upgrading through knowledge spillovers. Bo W U, Shengxiao L I. (2010) [42] believed that leading enterprises in the global value chain could drive the transformation and upgrading of enterprises in developing countries through knowledge spillovers and knowledge transfer. Rong-jian Y U. (2010) [43] believed that contract manufacturers conduct exploitative learning of the knowledge and technology transferred by leading enterprises, and also use the knowledge spillover effect for exploratory learning to promote GVC upgrading. Xiao-yan H U, Jiang G, Economics S O, et al. (2019) [44] found that technology spillovers from developed countries to developing countries could significantly improve developing countries's global value chain participation. Some scholars also believe that knowledge spillovers need to strengthen the cultivation of absorptive capacity of recipient countries. Piermartini, R Rubinova, S. (2021) [45] believed that GVC promotes the innovation capability of developed economies and emerging economies through international knowledge spillovers, and the precondition of international knowledge spillovers is that the knowledge recipient country has good knowledge absorption capacity.

Most scholars believe that the GVC involved in spatial spillover effects can be realized through FDI, but there are some differences on the direction of FDI's spatial spillover effect on the host country. Most studies taking developed countries as samples concluded that FDI will promote the productivity improvement of host countries through positive spatial spillovers (Blomstrom and Persson, 1983; Bitzer et al., 2008) [46,47]. However, the related research on developing countries has the opposite conclusion: FDI will have negative spatial spillover effect or no spillover effect on the productivity of the host country (Aitken and Harrison, 1999; Beugelsdijk et al., 2008; Demena, B A and Van Bergeijk, 2017) [48–50]. The main reason for this divergence is that the existing research mostly quantifies the spillover effects of transnational investment in technology space from the static macro dimension of "foreign direct investment stock" but ignores the dynamic attributes of the cross-border inflow and outflow of production factors and the systematic division of labor mechanism behind the cross-border circulation of advanced factors such as technology, capital and knowledge. Some scholars believe that the GVC involved in spatial spillover effects can be realized by resource reallocation structure. For example, Shao Chao-dui et al. (2017) [51] found that GVC produces both intra-regional and inter-regional spillovers to productivity, and such spatial spillovers are largely realized by improving the structure of resource reallocation in neighboring areas. This is mainly because GVC deepen the international division of labor, which improves the efficiency of resource utilization and reallocation, and promotes the improvement of production efficiency and economic growth through technology spillovers.

The existing literature has confirmed the driving effect of GVC participation on economic growth, and preliminary discussion has been carried out on the spillover effect of GVC. From a global perspective, however, empirical research with regard to the relationship between the global value chain and economic growth is still insufficient. The contribution of this paper is as follows: First, this paper expanded the research scope to the world and analyzed, through empirical study, the GVC activities on the spillover effect of economic growth. Second, in examining the effects of global value chain to participate in the economic growth, this paper investigated how the global value chain status index may increase the possible spillover effect on economic growth.

3. Index Measurement and Mechanism Analysis

3.1. Mechanism Analysis

A country or region can play its industrial structure and resource endowment advantages in the global market by participating in GVC production activities through its own comparative advantages. This has promoted the optimal allocation of resources worldwide and improved the efficiency of resource allocation. At the same time, the highly specialized international division of labor has led to the trend of large-scale production, which has promoted the scale efficiency of GVC participating countries. In addition, a country or

region's participation in GVC has improved technical efficiency and technological innovation ability through technology spillovers, international trade, international capital flows and other channels, thereby promoting economic growth. In recent years, the global value chain links have shown a trend of global accelerated expansion in spatial layout. The industrial structures of countries in the same value chain or region are interconnected and interdependent. Therefore, a country's economic growth needs to consider domestic factors of production, production efficiency and other factors, but also consider the economic development of neighboring countries and major trading countries. Economic growth has obvious spatial characteristics. According to spatial econometrics, there exists a certain spatial dependence between neighboring regions. The spatial spillovers of a country's participation in GVCS are mainly through horizontal spatial spillover channels and vertical spatial spillover channels. The vertical spatial spillover channel is mainly realized through industrial association and industrial transfer, while the horizontal spatial spillover channel is mainly realized through "demonstration and imitation", "inter-regional flow of factors" and "competition reversal mechanism".

Considering the research topic of this paper, this paper mainly analyzed the theoretical mechanism of horizontal spatial spillover channels. This paper assumes that there exist two countries, A and B. Country A directly participates in GVC activities, mainly in the production and processing of high-end core components. B is the neighboring country of A, which participates in the GVC to A shallower degree. The spatial spillover channel of "demonstration and imitation" is analyzed as follows: Country A directly participates in GVC activities and produces and processes high-end core components. Country B is A neighboring country of country A. Country B will take the initiative to learn the advanced production technology and management experience of country A, so as to realize the production of relevant products in this region and participate in GVC activities. The spatial spillover channel of "interregional flow of factors" is elaborated as follows: Country A's participation in GVC activities requires the integration of domestic and even international high-quality production resources, which largely exists the interregional flow of factors. The economic and trade exchanges between country A and country B are relatively close, which sets up A channel for the technology and management experience of country A to spill over to country B; The spatial spillover channel of "competition force mechanism" refers to that when country A participates in GVC activities, it faces increasingly fierce competition in the international market. In order to better participate in GVC activities, neighboring country B improves its own production efficiency and product quality by means of technological upgrading and innovative production. Therefore, this paper puts forward the following research hypothesis: the global economy is spatially dependent and global value chain to participate in the global economic growth has significant positive spatial spillover effects.

3.2. Participation Index and Status Index of Global Value Chain

Hmmels et al. (2001) [52] first proposed VS index and VS1 index to measure a country's GVC participation, for the first time for the research of global value chain provides a quantitative measure. On the basis of previous studies, Fally (2012) [53] and Antras et al. (2012) [54], respectively, constructed indicators of the length, upstream degree and downstream degree of the GVC, and provided more measures to determine a country's GVC status.. According to Koopman et al. (2010, 2014) [55,56], the value added of a country's export is divided into four parts: the part of the value added export that was absorbed by foreign countries, the part of the value added export that was returned to domestic, the part of the foreign value added included in the export, and the part of the trade in intermediate goods that was repeatedly counted. They Construct GVC participation and status index and other indicators are constructed to provide updated measurement methods for the GVC status. The WWZ decomposition method proposed by Wang et al. (2014) [57] is the latest representative achievement in the study of global value chain. Wang et al. (2014) [57] improved the decomposition method of GVC based on Koopman's previous research and

decomposed the global value chain into 17 specific indicators. The application of GVC decomposition is expanded from the national level to the industry level, national level, and bilateral trade level, which greatly expands the research content and analysis methods of GVC.

Referring to the research results of Wang et al. (2014) [57], this paper mainly used the GVC participation index and the GVC status index proposed by Koopman to measure the position of a country in the GVC. The GVC Participation index was calculated using the following formula:

$$\text{GVC\_Participation} = \frac{IV}{E} + \frac{FV}{E}$$

IV is the indirect domestic value added of a country's total exports. FV is the value added from abroad of a country's total exports. E is a country's total exports. IV/E can be understood as the forward participation of a country in GVCS. FV/E is the backward participation. The higher the GVC participation index, the more deeply a country participates in the GVC division of labor. However, theoretically speaking, the promotion of the global value chain status can better reflects the upgrading of a country's comprehensive innovation capability in the governance system and governance capability, market, industry and other fields. Compared with the increase of participation in the global value chain, it is a "qualitative change", which means that a country is responsible for producing intermediate products with more technical content and at a higher end of the value chain.

The calculation formula of GVC status index is as follows:

$$\text{GVC\_Position} = \ln\left(1 + \frac{IV}{E}\right) + \ln\left(1 + \frac{FV}{E}\right)$$

According to Koopman, the two indicators of GVC participation and status index can reflect the degree of a country's participation in GVCS. A high GVC status index of a country indicates that the forward participation in GVC is higher than the backward participation. If a country is in a higher position in GVC production, it will be more engaged in the production of raw materials or intermediate products or product design. The lower the GVC status index, the higher the backward participation of a country in the GVC. It means that one country needs to import a lot of intermediate goods produced in other countries. Through the above analysis, it can be found that the higher the importance of the country or region in the global value chain, the more benefits can be obtained from GVC production activities, which is conducive to long-term economic growth.

3.3. Spatial Characteristics of World Economic Growth

Before performing spatial analysis, the data should first be examined for spatial dependence. In other words, the existence of spatial correlation of economic growth is the premise of subsequent analysis. Spatial autocorrelation mainly means that the values of a variable in the neighboring region have certain similarity. According to the general idea of spatial econometric method, in this paper, the common Moran index is used to analyze the spatial correlation of global economic growth. The value of Moran's I index reflects the size of spatial correlation, which is generally between -1 and 1. If there is a positive spatial correlation, the Moran's I index will be greater than zero, and vice versa. The closer the Moran's I index is to zero, the weaker the spatial correlation.

GVC participation index and status index depend on the WIOD database compiled by EU. At the same time, WIOD has a good time series data table. The GDP of countries and regions included in this database accounts for more than 85% of the world, which is widely representative. The research scope of this paper is from 2000 to 2014, and 42 countries are selected as research objects. Details of these 42 countries are provided in the Appendix A. In this paper, regional economic growth is represented by logarithm of per-capita GDP. The results show (see Table 1) that the Moran's I index of the log of per-capita GDP of 42 countries from 2000 to 2014 is positive. From 2000 to 2014, Moran's I index of all years passed the significance level test of 5%. The maximum value of Moran's I index is 0.6 and

the minimum value is 0.4. This indicates that the economic growth of 42 countries has a positive spatial correlation. This provides a basis for the spatial regression method in this paper.

Table 1. Spatial correlation test of global economic growth from 2000 to 2014.

Year	Moran's I	Z-Value	*p*-Value	Year	Moran's I	Z-Value	*p*-Value
2000	0.579	4.793	0.000	2008	0474	4.038	0.000
2001	0.570	4.726	0.000	2009	0.497	4.194	0.000
2002	0.561	4.661	0.000	2010	0.505	4.254	0.000
2003	0.555	4.618	0.000	2011	0.500	4.224	0.000
2004	0.538	4.491	0.000	2012	0.481	4.073	0.000
2005	0.519	4.354	0.000	2013	0.474	4.022	0.000
2006	0.507	4.270	0.000	2014	0.473	4.003	0.000
2007	0.492	4.157	0.000				

4. Econometric Model and Variable Description

4.1. Setting of Spatial Econometric Model

A country participating in GVC division of labor will inevitably import intermediate goods from other countries or export intermediate goods to other regions. Therefore, the level of a country's GVC participation will affect the economic development of its major trading partners. Similarly, the GVC participation degree of major trading partners will affect their economic development. The spatial lag model is introduced to improve the scientificity of the analysis and the stability of the results.

$$\text{lngdpg}_{it} = \lambda W\text{lngdpg}_{it} + \beta lngvcpt_{it} + \delta cont_{it} + \mu_{it} + \varepsilon_{it}$$
$$\text{lngdpg}_{it} = \lambda W\text{lngdpg}_{it} + \beta lngvcpo_{it} + \delta cont_{it} + \mu_{it} + \varepsilon_{it}$$

where i stands for different countries and t stands for year. The explanatory variable is LNGDPG, which represents the economic growth of a country and is expressed by logarithm of the country's per-capita GDP. λ represents the spatial autoregressive coefficient in the model. The space weight matrix in the model is represented by W. If λ is greater than zero, there is obvious spillover effect between neighboring regions. If λ is less than zero, neighboring countries or regions may have a siphon effect on that country. A country's participation in GVCS is represented by LNGVCPT, and it is expressed by taking the logarithm of the GVC participation index. LNGVCPO represents the status of a country in the GVC. It is expressed in logarithm of the GVC Position index. *Cont* represents the control variable. According to existing research results, the following control variables are selected in this paper: Openness is expressed as foreign trade as a share of GDP; Government spending as a share of GDP is used to represent the government expenditure scale (GOV); The proportion of urban population is used to represent the urbanization level (Urban); Foreign direct investment (FDI) is represented by the net inflow of foreign direct investment; R & D investment in science and technology (RD) is represented by a percentage of GDP; Human capital (HK) is represented by per capita capital; The industrial structure (INS) is represented by the sum of the proportion of the second and third industries in GDP; Infrastructure construction level (INF) is represented by the country's total rail mileage divided by the total land area.

The spatial lag of exogenous variables is prone to bias, so Lesage and Pace (2009) [58] proposed the spatial panel Durbin model to ensure the unbiased estimation results. Use of space Durbin model, this paper analyzed between countries the overflow of relationship

between economic growth and global value chain to participate in. According to the above analysis, this paper adopts the following analysis model:

$$\text{lngdpg}_{it} = \lambda W\text{lngdpg}_{it} + \beta lngvcpt_{it} + \rho Wlngvcpt_{it} + \delta cont_{it} + \mu_{it} + \varepsilon_{it}$$
$$\text{lngdpg}_{it} = \lambda W\text{lngdpg}_{it} + \beta lngvcpo_{it} + \rho Wlngvcpo_{it} + \delta cont_{it} + \mu_{it} + \varepsilon_{it}$$

According to Lesage and Pace (2009) [58], although the coefficient of the spatial lag term is significant and not 0, the spatial spillover effect cannot be directly concluded. For this reason, Lesage and Pace proposed the partial differential method of spatial regression. Using this method, the spatial spillover effect is divided into direct effect and indirect effect. The direct effect can be understood as the spillover effect of explanatory variables on explained variables in the local region, and the indirect effect represents the spillover effect of explained variables on explanatory variables between regions. The total effect is equal to the direct effect plus the indirect effect and is also the spatial regression coefficient of the explanatory variables.

In order to improve the robustness of the results, this paper selects three different types of spatial weight matrices for spatial econometric analysis based on existing studies. First, the binary spatial weight matrix is selected which main diagonal is 0. The off-diagonal elements of the matrix are denoted as 1 if the two countries share a common land border, and 0 if they do not. Secondly, this paper chooses the spatial weight matrix based on geographical distance. According to the research results of Zhang Cuiju et al. (2015) [59], from the global perspective, the binary spatial weight matrix may ignore the influence of geographical distance on the bilateral trade content of two countries. In order to make the analysis results credible, this paper added the geographical distance to construct the geographical distance spatial weight matrix for spatial analysis. The spatial weight matrix is characterized by 0 elements on the main diagonal and the surface distance between the capitals of the two countries on the off-main diagonal. The capital of a country is generally the political and economic center of the country, so in this paper, the non-main diagonal element is set as the reciprocal of the distance between the capitals of two countries. The spatial weight matrix is calculated by GeoDA software. On the basis of the above two spatial weight matrices, considering that the import and export of intermediate products is an important way of GVC activities, the economic development degree of two countries will significantly affect the trade volume between the two countries. In other words, the interaction between the bilateral economies of the two countries will be obviously affected by the economic volume of the two countries. Through the above analysis, the spatial weight matrix based on gravity model is set up in this paper.

$$w_{ij} = Y_i Y_j / D_{ij}$$

w_{ij} is the element on the off-diagonal of the spatial weight matrix based on the gravity model.Y_i and Y_j is the total GDP of countries i and j respectively. The geographical distance between the capitals of countries i and j is denoted by D_{ij}. The GDP data for each country comes from the World Bank's website, and geographical distances are also measured by Geoda software.

In theory, the size of the economy reflects the size of the potential market of the two economies, while the volume of trade directly reflects the size of bilateral trade flows. Based on the gravity model, this paper further expands the setting of spatial weight and adds bilateral trade flows into the spatial weight. T_i and T_j are the total imports and exports of countries i and j respectively, represented by the sum of imports and exports are respectively the total import and export of the two trading countries, which are represented by the sum of import and export. The geographical distance between the capitals of countries i and j is denoted by D_{ij}. Anderson and Van Wincoop (2003) [60] point out that "the disappearance of the distance factor is exaggerated. Even when trade policy barriers are removed, trade costs remain high between seemingly highly integrated economies". In order to further accurately describe bilateral trade costs, this paper adds bilateral trade costs into the gravity

model of trade, which is expressed as the product of the reciprocal of 1+ weighted average applicable tax rates of all products of the two countries.

$$w_{ij} = a_{ij}T_iT_j/D_{ij}$$

4.2. Data Sources

Given the availability of data, the GVC Participation and Status indices rely on the WIOD database prepared by the European Union. This paper selects panel data sets of 42 major countries from 2000 to 2014 available in WIOD data, and the economic data at the national level are all from the World Bank database. Specific data such as IV, FV and E in GVC Participation Index and Status index are from UIBE database. The specific data were calculated by the author.

5. Empirical Test and Result Analysis

5.1. Economic Growth and Spillover Effects of Global Value Chain Participation

According to the results of Hausman test, random effects are selected in this paper. According to the research results of (Silva, J.S., & Tenreyro, S., 2006; Santos Silva, J.M.C., & Tenreyro, S., 2022) [61,62], The author added robust option to spatial Durbin model analysis to ensure the effectiveness of measurement results. The empirical results for model (1) in Table 2 show that the coefficient of LNGVCPT passes the 5% significance test under the three spatial weights. The results all support that the improvement of GVC participation has a positive driving effect on economic development. Increased participation in global value chains also means closer economic exchanges between a country and the rest of the world. In recent years, multinational enterprises have expanded rapidly in the world. The knowledge spillover, demonstration and imitation effects caused by multinational enterprises have effectively promoted the improvement of production efficiency and the play of comparative advantages of developing countries. At the same time, it further effectively promoted the economic growth of the country. For developing countries, the improvement of their participation in the global value chain can undertake the industrial transfer of developed countries and import more machinery manufacturing equipment and intermediate products to achieve their own economic growth and effective improvement of production efficiency. For developed countries, the improvement of their GVC participation can give better play to their technological and capital advantages and can access a wider international market. The improvement of the degree of participation in global value chains is more intuitively reflected in the growth of bilateral trade volume. In fact, the value added of GVC links (the sum of traditional trade production, simple GVC production activities and complex GVC production activities) increased from 15% of a country's total output value in 1995 to over 20% in 2014. Since 2012, GVC trade already in world trade accounted for 60–67% of the share (the sum of simple GVC production activities and complex GVC production activities), indicating the importance of GVC.

Table 2. Estimation results of GVC participation and economic growth.

	Binary Space Weight	**Geospatial Weight**	**Spatial Weight of Economic Gravity Model**	**Weight of Bilateral Trade Gravity Model**
λ	0.322 *** (3.67)	12.34 *** (5.33)	0.844 *** (18.16)	0.820 *** (15.61)
lngvcpt	1.346 *** (5.49)	0.880 *** (2.96)	0.324 ** (2.33)	0.281 * (1.82)
lnopen	−0.412 *** (−2.70)	−0.434 *** (−3.05)	−0.480 *** (−3.13)	−0.437 *** (−2.78)

Table 2. *Cont.*

	Binary Space Weight	Geospatial Weight	Spatial Weight of Economic Gravity Model	Weight of Bilateral Trade Gravity Model
lngov	0.373 * (1.78)	0.219 (1.07)	−0.151 (−0.84)	−0.130 (−0.67)
lnurban	0.524 (1.15)	1.229 *** (2.77)	0.060 (0.14)	0.109 (0.27)
lnrd	0.333 *** (4.73)	0.339 *** (5.02)	0.201 *** (2.66)	0.201 *** (2.68)
lnfdi	−0.019 *** (−3.29)	−0.014 ** (−2.13)	−0.014 ** (−2.52)	−0.014 ** (−2.50)
lnhk	0.602 *** (8.35)	0.653 *** (8.51)	0.599 *** (9.62)	0.579 *** (9.35)
lnins	4.322 *** (3.54)	5.899 *** (5.11)	5.154 *** (4.36)	5.223 *** (4.59)
lninf	−0.416 *** (−2.78)	−0.327 (−1.16)	−0.0697 (−1.52)	−0.069 * (−1.69)
Constant term	−15.67 *** (−2.60)	−27.44 *** (−5.07)	−24.44 *** (−4.95)	−24.89 *** (−5.17)
R^2	0.569	0.443	0.806	0.850
Obs	630	630	630	630

Note: *, **, *** respectively 10%, 5% and 1% significance level, number of Z test value in parentheses. The significance annotation method is the same for all tables in this paper.

The analysis results of spatial Durbin model are shown in Table 3. As can be seen from the above results, the direct effect of GVC participation is positive in the binary and geographical distance spatial weights, and both pass the significance level test at the 1% level. This suggests that GVC participation still boosts domestic economic growth after accounting for spatial spillovers from GVC participation. Meanwhile, the empirical results show that the indirect effect coefficient of GVC participation index is also significantly positive. It shows that the increase of a country's global value chain participation will not only promote its own economic growth, but also produce obvious spatial spillover effects on neighboring countries or regions. From the perspective of the estimated coefficient of indirect effect, from the binary spatial weight matrix and the spatial weight matrix of geographical distance to the spatial weight matrix based on gravity model, the coefficient of indirect effect is increasing. This suggests that the spatial spillovers of GVC participation are more pronounced when economic size is taken into account. In general, the larger the size and scale of two countries' economies, the greater their trade potential and trade size. As the two countries trade more in goods and services, they can enjoy more economic growth from GVCS. The spillover effect of GVCS is also related to geographical distance. The closer the geographical distance is, the more frequent the trade between the two countries will be. Human resources, capital, and other production factors of the two countries can be circulated between the two countries at a lower cost, which also effectively drives the economic growth of the two countries. GVCS will also produce "involuntary spillover effects" on neighboring countries. In bilateral trade, GVCS will spillover to neighboring countries through involuntary diffusion and dissemination of economic growth. In addition, multinational enterprises and intermediate goods trade are also important ways to promote the spillover of global value chains to economic growth.

Table 3. Spillover effects of global value chain participation on economic growth.

	Binary Space Weight	Geospatial Weight	Spatial Weight of Economic Gravity Model	Weight of Bilateral Trade Gravity Model
lngvcpt	0.948 *** (3.07)	0.693 ** (2.25)	−0.146 (−0.67)	−0.173 (−0.73)
lnopen	−0.342 ** (−2.53)	−0.367 ** (−2.55)	−0.457 *** (−3.06)	−0.409 *** (−2.71)
lngov	0.396 * (1.88)	0.212 (1.09)	−0.0928 (−0.52)	−0.070 (−0.37)
lnurban	0.290 (0.79)	0.794 * (1.80)	0.016 (0.04)	0.058 (0.14)
lnrd	−0.020 *** (−3.34)	−0.014 ** (−2.11)	−0.013 ** (−2.31)	−0.012 ** (−2.24)
lnfdi	0.336 *** (6.43)	0.318 *** (4.85)	0.183 ** (2.46)	0.182 ** (2.46)
lnhk	0.632 *** (9.75)	0.648 *** (8.22)	0.576 *** (9.69)	0.563 *** (9.39)
lnins	4.312 *** (3.38)	6.332 *** (4.87)	5.329 *** (4.46)	5.429 *** (4.66)
lninf	−0.200 *** (−2.62)	−0.123 * (−1.84)	−0.082 (−1.61)	−0.077 * (−1.75)
Constant term	−14.88 *** (−2.72)	−26.06 *** (−4.63)	−23.51 *** (−4.79)	−23.97 *** (−4.92)
ρ	1.034 *** (4.55)	36.56 *** (6.09)	0.975 *** (3.60)	0.986 *** (3.46)
λ	0.189 *** (4.64)	4.759 *** (6.16)	0.749 *** (11.30)	0.704 *** (10.10)
Direct effect	1.032 *** (3.46)	0.718 ** (2.29)	−0.051 (−0.23)	−0.093 (−0.40)
Indirect effect	1.168 *** (5.47)	1.306 *** (6.99)	3.534 *** (3.51)	2.912 *** (4.11)
Total effect	2.200 *** (11.60)	2.024 *** (9.79)	3.483 *** (3.53)	2.819 *** (4.31)
R^2	0.887	0.912	0.792	0.843
Obs	630	630	630	630

Note: *, **, *** respectively 10%, 5% and 1% significance level, number of Z test value in parentheses.

5.2. Economic Growth and Spillover Effects of Global Value Chain Position

Table 4 reports the spillover relationship between GVC position and economic growth. The coefficient λ is significantly positive at the 1% level, again proving the existence of spatial correlation in global economic growth. The coefficient before LNGVCPO is significantly positive (at the 10% level). This shows that the promotion of global value chain status promotes economic growth. Different from GVC participation, GVC position mainly reflects a country's position in the international division of production. Generally speaking, developing countries are at the lower end of the GVC. In GVC production mode, developing countries are mainly engaged in production links with low added value. For developing countries, the import of intermediate goods from developed countries and the global production line layout of multinational companies can bring technological spillovers and technological upgrading to developing countries. This will help developing countries move towards the middle and high end of the global value chain, while also contributing to long-

term economic growth. In contrast, developed countries in the upper reaches of the global value chain usually have advantages in capital and technology as well as management, and they can occupy various advantages in the international division of production. Developed countries have obtained more added value by importing intermediate products from developing countries and transferring labor-intensive industries to developing countries. This will provide more lasting impetus for economic development.

Table 4. Global value chain position and economic growth estimation results.

	Binary Space Weight	Geospatial Weight	Spatial Weight of Economic Gravity Model	Weight of Bilateral Trade Gravity Model
λ	0.458 *** (6.31)	0.738 *** (15.99)	0.898 *** (29.79)	0.874 *** (24.61)
lngvcpt	0.030 * (1.76)	0.020 * (1.74)	0.020 (1.59)	0.020 (1.57)
lnopen	−0.071 (−0.55)	−0.334 *** (−2.60)	−0.421 *** (−3.15)	−0.395 *** (−2.85)
lngov	0.950 *** (3.96)	−0.046 (−0.24)	−0.098 (−0.56)	−0.104 (−0.56)
lnurban	0.789 (1.10)	0.258 (0.73)	0.134 (0.34)	0.179 (0.48)
lnrd	0.321 *** (3.46)	0.161 ** (2.21)	0.182 ** (2.57)	0.182 ** (2.55)
lnfdi	−0.016 *** (−2.77)	−0.0132 ** (−2.40)	−0.013 ** (−2.33)	−0.013 ** (−2.32)
lnhk	0.664 *** (7.23)	0.571 *** (9.50)	0.614 *** (9.11)	0.588 *** (8.96)
lnins	5.975 *** (4.35)	5.153 *** (4.77)	5.584 *** (4.42)	5.541 *** (4.64)
lninf	−0.511 ** (−2.45)	−0.0621 (−1.56)	−0.070 (−1.56)	−0.068 * (−1.67)
Constant term	−29.89 *** (−4.36)	−25.03 *** (−5.56)	−28.07 *** (−5.46)	−27.75 *** (−5.66)
R^2	0.490	0.873	0.807	0.841
Obs	630	630	630	630

Note: *, **, *** respectively 10%, 5% and 1% significance level, number of Z test value in parentheses.

Table 5 shows the use of the spatial Durbin model to analyze the spillover effects of GVC status on economic growth. Through analysis, it is found that the spatial spillover effects of global value chain status changes on economic growth only pass the significance test in the binary-based spatial weight matrix and the geographic distance-based spatial weight matrix. Nevertheless, the above two results still confirm that the improvement of global value chain status not only has a positive driving effect on domestic economic growth (the direct effect coefficient is significantly positive), but also has a spillover effect on neighboring countries (the indirect effect coefficient is positive and also significant). And the improvement of the status of the global value chain has a significantly stronger spillover effect on the economic growth of neighboring countries than the driving effect on the domestic economic growth (the coefficient of indirect effect is obviously larger than that of direct effect). In the production link of the global value chain, countries at the upper end are mainly engaged in research and development, design, and other links, and most of them are developed countries. In the world economy, the growth rate of developed countries is obviously behind that of emerging economies. After the 2008 financial crisis,

most developed economies fell into slow growth. Among the 42 countries studied in this paper, many developed countries, such as Greece, Italy, and Japan have fallen into the quagmire of economic growth, although they are in the upper reaches of the global value chain. In order to get out of the predicament, the global production model led by developed countries has gradually deepened vertically and expanded horizontally. Typically, countries at the upper reaches of the global value chain play an important role in industrial transfer, multinational enterprises, capital export, trade in goods and services. Due to the restriction of geographical distance and cultural distance, as well as industrial transfer, multinational enterprises still prefer neighboring countries and regions when setting up branches outside. Therefore, a country is in the middle and upper reaches of GVC, and neighboring countries are often the first to benefit. Imitation and interregional flow of factors first occurred in neighboring countries. The spillover effect is mainly realized through various channels, such as "non-resource diffusion", optimal allocation of resources, transnational flow of production factors, trade of intermediate goods and technology spillover.

Table 5. Spillover effect of global value chain status on economic growth.

	Binary Space Weight	**Geospatial Weight**	**Spatial Weight of Economic Gravity Model**	**Weight of Bilateral Trade Gravity Model**
lngvcpt	0.030 *	0.022 *	0.020 ***	0.012 ***
	(1.86)	(1.93)	(3.18)	(3.20)
lnopen	−0.0887	−0.358 ***	−0.420 ***	−0.404 ***
	(−0.69)	(−2.73)	(−9.07)	(−8.78)
lngov	0.950 ***	−0.035	−0.114	−0.086
	(4.05)	(−0.19)	(−1.32)	(−1.01)
lnurban	0.816	0.201	0.134	0.154
	(1.16)	(0.56)	(0.84)	(0.97)
lnrd	−0.017 ***	−0.014 ***	−0.013 ***	−0.013 ***
	(−2.92)	(−2.65)	(−3.45)	(−3.31)
lnfdi	0.318 ***	0.163 **	0.182 ***	0.179 ***
	(3.63)	(2.31)	(6.09)	(6.04)
lnhk	0.671 ***	0.575 ***	0.611 ***	0.593 ***
	(7.40)	(9.71)	(22.60)	(21.79)
lnins	5.952 ***	5.235 ***	5.541 ***	5.589 ***
	(4.13)	(4.79)	(9.65)	(9.77)
lninf	−0.475 **	−0.0621	−0.071 **	−0.068 **
	(−2.23)	(−1.56)	(−1.98)	(−2.02)
Constant term	−30.07 ***	−24.83 ***	−27.78 ***	−27.94 ***
	(−4.30)	(−5.54)	(−11.25)	(−11.45)
ρ	0.042 ***	0.092 **	−0.017	0.036 **
	(2.83)	(2.51)	(−0.93)	(1.98)
λ	0.470 ***	0.737 ***	0.890 ***	0.889 ***
	(6.59)	(16.15)	(39.40)	(40.99)
Direct effect	0.041 **	0.032 **	0.021 **	0.033 ***
	(2.16)	(2.20)	(2.20)	(3.13)
Indirect effect	0.081 ***	0.428 **	0.024	0.500 *
	(2.69)	(2.05)	(0.12)	(1.94)
Total effect	0.122 ***	0.460 **	0.044	0.532 **
	(2.72)	(2.10)	(0.22)	(2.00)
R^2	0.493	0.865	0.808	0.827
Obs	630	630	630	630

Note: *, **, *** respectively 10%, 5% and 1% significance level, number of Z test value in parentheses.

6. Main Conclusions and Policy Implications

On the basis of the existing research literature, this paper used the World Bank database, WIOD database and UBIE database for analysis. This paper used spatial autoregressive model and spatial Durbin model to deconstruct the driving and spillover effects of GVC participation and GVC position of 42 countries on economic development from the perspective of space. The research results are as follows: First, the improvement of global value chain participation not only has an obvious spillover effect on domestic economic growth, but also has an obvious driving effect on the economic development of neighboring countries. Second, a country's GVC position has been improved, indicating that its comprehensive innovation capability has been improved. The country can gain more benefits from GVC production activities, which is conducive to long-term economic growth. Third, the promotion of global value chain status not only has a significant role in stimulating domestic economic growth, but also significantly promotes the economic development of surrounding countries through spatial spillover effects. Moreover, the spillover effect of the promotion of global value chain status on the economic growth of neighboring countries is obviously stronger than the driving effect on the domestic economy.

Today's world economy is beset by "de-globalization" and "slow globalization" factors, such as the global pandemic of COVID-19, geopolitical conflicts, etc. This study also brings some enlightenment to countries to promote sustainable economic growth. First, countries should continue to adhere to the concept of inclusive and open development, make full use of existing international trade rules to actively conduct international negotiations, and promote the continuous reduction of various trade costs. This can further improve the level of trade facilitation and liberalization, expand the scope of participation in the global value chain, and deepen the level of participation. Second, countries should make full use of the existing international open platforms to develop global or regional trade partnerships and build a harmonious and stable GVC or RVC to withstand the impact of external uncertainties. At the same time, relatively developed countries can take this opportunity to enhance the absorptive capacity of GVC spatial spillover effects of relatively backward countries and strengthen the spatial connection and division of labor cooperation with GVC participating regions. In this way, countries can better enjoy the spillover effect of the surrounding countries' GVC participation and status improvement on their own economic development and give full play to the positive impact of GVC participation. Third, emerging economies should speed up the cultivation of various emerging industries and improve the international competitiveness of traditional industries, and further accelerate the construction of industrial clusters with international competitiveness. The government should guide and encourage enterprises and universities to increase investment in innovation and provide appropriate tax relief and financial support. This can speed up the industrial technological innovation of emerging economies and avoid being "low-end locked". In this way, emerging economies are climbing towards the high-end of GVC. Finally, enterprises in emerging economies should realize that improving technological innovation capability is the only way for enterprises to develop in the long run and cope with the increasingly fierce international competition. While accelerating learning and absorbing international technology diffusion and spillovers, enterprises in emerging economies should also accelerate the construction of core competitiveness and enhance local innovation capabilities.

7. Limitations and Future Research Directions

It is undeniable that this article does have some limitations. First, this paper did not consider the factors that have led to GVC restructuring in recent years, such as industrial returns, GOVID-9, Russia Ukraine war, etc. This paper does not include the above factors into the GVC's spatial spillover analysis of economic growth. Second, this paper failed to analyze the vertical spatial spillover effect of a country's participation in GVC spatial spillovers from the perspective of international industrial transfer. Finally, this paper only analyzed the spatial spillover channels of GVCs from the perspective of trade flows,

without considering economic realities, such as trade policy (Helpman, E., & Krugman, P. 1989) [63] and country size (Shelburn, R.C., 2002) [64]. In future research, the author will fully incorporate the above limitations into the theory and model, and then analyze the spatial spillover effect of GVC on economic growth in detail, so as to draw a conclusion more suitable for the current economic situation.

Author Contributions: Methodology, K.M. and H.S.; resources, K.M.; data curation and analysis, K.M.; writing—original draft, K.M., H.S. and M.K.; writing—review and editing, K.M.; polish, K.M.; supervision, H.S. and K.M. All authors have read and agreed to the published version of the manuscript.

Funding: "One Belt and One Road" Education International Cooperation Special Research Project of Ministry of Education of China (Fund number: 19YDYL31).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We would like to extend special thanks to the editor and the anonymous reviewers for their valuable comments in greatly improving the quality of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

In this paper, 42 countries are selected as research objects, as follows: AUS, AUT, BEL, BGR, BRA, CAN, CHE, CHN (including Taiwan, China), CYP, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IDN, IND, IRL, ITA, JPN, KOR, LTU, LUX, LVA, MEX, MLT, NLD, NOR, POL, PRT, ROU, RUS, SVK, SVN, SWE, TUR and USA.

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